Learning by Doing: Valuing Energy Efficiency in Distribution System Planning

Dan Aas, Energy and Resources Group, UC Berkeley

ABSTRACT

A central tenant of energy policy is that utility planning should treat energy efficiency as a resource comparable to generators. Today, integrated resource plans are beginning to be supplemented by higher resolution planning that focuses on how distributed energy resources (DERs) can be effectively integrated into the grid. California is in the process of implementing distribution level planning via recently filed utility Distribution Resource Plans (DRPs). In these plans, utilities completed feeder level analyses of their networks to identify both the capacity of the distribution system to integrate DERs *and* where DERs can provide the most value via grid services. Energy efficiency investments modify load and increase the hosting capacity for other DERs on the grid, so we would expect that cost-effective DRPs would include substantial energy efficiency investments.

This paper characterizes how California utilities used both active and passive strategies to include energy efficiency in their DRPs. The role of energy efficiency in the DRPs is examined through an existing framework for integrated resource planning that delineates 'passive' and 'active' strategies to include energy efficiency in resource planning. Both passive and active energy efficiency strategies are hypothesized to be useful in distribution planning processes. However, each strategy requires refinement before the full value of energy efficiency as a resource can be realized in the electricity distribution system.

Introduction

The electric power sector is capital intensive and technically complex. Reliable and low cost electricity requires effective resource planning by utilities and through the regulatory process. In the 1980s, integrated resource planning (IRP) emerged as a means to ensure that utility investments not only provide universally available and reliable power, but also that investments reflect societal goals, like safeguarding the environment, at a reasonable cost (Hirsch 1999). Energy efficiency is an important component of IRP processes because it is well aligned with a multitude of societal goals and is low-cost (Lazar 2013). Today, rapidly declining costs of distributed energy resources (DERs)[1] have led regulators to implement or consider IRP-like processes scaled down to the distribution system. Similar to the bulk system, societal goals for

[1] The definition of distributed energy resources typically includes solar, storage, and demand response.

the distribution system are broader than just safe and reliable electric power. If these goals are to be achieved cost-effectively, energy efficiency must play a substantial role in distribution planning.

This paper identifies lessons learned for including energy efficiency from past IRP processes and the initial application of a distribution planning process in California. Section 1 examines how energy efficiency has been included in IRPs and highlights a distinction between 'passive' versus 'active' inclusion of energy efficiency in resource planning. Section 2 describes the California Distribution Resource Plan (DRP) proceeding, with a focus on the degree to which utility filings include energy efficiency in a passive or active manner. Section 3 offers an analysis of barriers to inclusion of energy efficiency in processes like the California DRP and promising solutions to overcome those barriers.

1. Lessons for Energy Efficiency from Integrated Resource Planning

A key premise of energy efficiency policy is that demand side measures can and should be considered as resources on par with conventional supply side alternatives. Integrated resource plans are one venue through which energy efficiency is considered as a resource.

A variety of approaches have been used to include energy efficiency as a resource in IRPs. Neme and Sedano (2012) categorize these approaches into two strategies. The first strategy, what the authors call 'passive,' is to treat energy efficiency savings as an input to demand forecasts. With load modified, a passive approach then focuses on choosing the right types of generation to meet jurisdictions' preferred mix of cost and societal goals. Passive strategies can be further divided into those that only include energy savings targets associated with existing policy commitments and scenario-based strategies that allow for variation in achieved savings. The second strategy for including energy efficiency in IRPs, deemed 'active' by Neme and Sedano (2012), identifies energy efficiency savings targets based on the relative costs of programs compared to conventional alternatives. In a study of six utilities' approaches to IRP, Lamont and Gerhard (2013) found that five of the utilities adopted a passive approach to include energy efficiency savings. Among the utilities they considered, only PacifiCorp[2] used an approach that fits the definition of active. PacifiCorp's active approach is based on a supply curve of energy efficiency measures and programs. To simplify, the measures that are more cost effective than generation alternatives are included in PacifiCorp's IRP.

At a bulk system level, a passive approach – particularly one that incorporates multiple energy savings scenarios – may be sufficient to inform an IRP that reflects the goals of society (e.g. reduced air pollution, a reliable supply of power). Accurate forecasts of the impact of energy efficiency on load in a state or market puts pressure on the economics of both existing and proposed generators, avoiding unnecessary capital expenditures and air pollution. However,

[2] A similar process for IRP is used by the Northwest Power and Conservation Council on behalf of the Bonneville Power Administration.

active strategies create space for energy efficiency savings that are additional to those delivered via policies and programs to be identified before large infrastructure investments are made.

2. Active Versus Passive Deferral in Distribution Planning: Lessons from California

The planning scale of IRPs is much larger than that of new distribution planning proceedings. Distribution planning is done within specific geographies [Figure 1] that can range from the busbar where the distribution grid interacts with wholesale markets, down to relatively small segments of individual circuits (CAISO 2015). The geographic specificity of distribution planning may therefore require a greater degree of granularity on where energy efficiency savings occur. However, some forms of energy efficiency savings (e.g. building codes, appliance standards, deemed savings programs) are not easily attributed to any one location. In some instances the location of savings can be determined with more specificity, but it is not always the case that utilities effectively share information between their energy efficiency program administrators and distribution grid planners (Neme and Grevatt 2015). Siloing of utility operational divisions limits the efficacy of both passive and active approaches to include energy efficiency in resource planning.

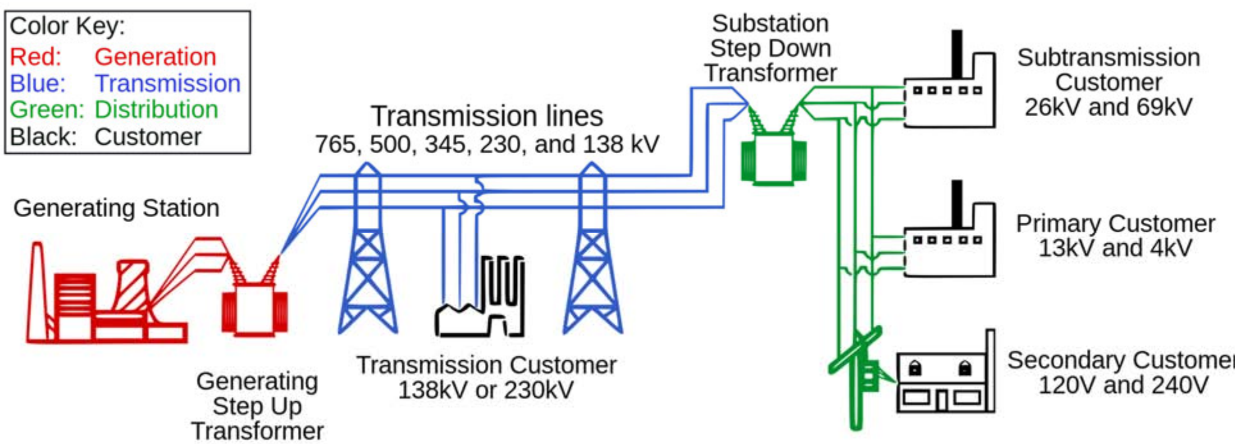

Figure 1: The electric power sector from generator to end-use. *Source:* United States Department of Energy 2004

2.1. California's Distribution Planning Process

California utilities, policymakers and parties to proceedings have begun to wrestle with the challenge of how to ensure the state's substantial energy efficiency policy commitments are effectively included in utility distribution planning. In 2014, the California Public Utilities Commission (CPUC) initiated a DRP proceeding[3] that laid out the following goals for utilities: 1) characterize the ability of the utilities' systems to accommodate additional DERs, 2) develop an approach to assign locational values in the distribution system, 3) offer projections of DER growth and how that growth affects infrastructure investments, and 4) initiate pilot projects to demonstrate innovative technical and operational approaches to integrate DERs (CPUC 2014). In 2015, the California Investor-Owned Utilities (IOUs) filed distribution resource plans that described their proposed strategies to meet those goals (PG&E 2015; SCE 2015; SDG&E 2015).

2.2 Passive Approaches

California has implemented a number of policies that support the deployment of DERs. In each DRP, California IOUs describe their methodology for forecasting (through "DER Growth Scenarios") how policies and market trends will affect DER penetrations on their systems over the next ten years. The utilities' common starting point is the Integrated Energy Policy Report (IEPR) developed by the California Energy Commission (CEC) (PG&E 2015, SCE 2015, SDG&E 2015). The energy efficiency section of the IEPR aggregates the impacts of California's building codes, appliance standards, and utility energy efficiency programs into a single savings category called Additional Achievable Energy Efficiency (AAEE) (CEC 2015). AAEE is offered as a statewide, regional, and IOU service territory figure.

The California utilities' use of AAEE as the starting point for including energy efficiency in their DRPs is consistent with the passive strategies included in many other utilities' IRPs. However, with respect to distribution planning, the path to energy efficiency achieved through utility programs is not direct, as illustrated by Figure 2.

Figure 2: The California energy efficiency planning process as it pertains to distribution planning. *Source:* Author

[3] A second proceeding on the IEPR has also begun in order to specify how DERs should be procured given the technical needs identified in DRP filings (CPUC 2015). Though these two proceedings are complementary, this paper focuses on the DRP process that is in a more advanced stage.

The development of AAEE begins with IOU energy efficiency managers identifying a portfolio of cost-effective programs and the associated program savings. Program savings are then incorporated into the IEPR development process, where they are combined with additional savings from building codes and appliance standards. AAEE forecasts are then developed and disaggregated by climate zone. In order to facilitate more effective planning, utilities have worked with CEC and the California Independent System Operator to further disaggregate savings to the busbar level (PG&E 2015). Distribution planning is location specific, so statewide or regional savings numbers are likely to be of limited use when the need for an upgrade on a given circuit is identified. Savings projections at the busbar level may be more helpful than regional or service territory level figures, but still may not be sufficient to defer, or eliminate the need for, many distribution system investments.

Pacific Gas and Electric (PG&E) and Southern California Edison (SCE) offer strategies in their DRPs to further disaggregate AAEE projections to better inform planning for individual distribution substations or circuits. SCE's strategy combines the projected load shapes of energy efficiency measures in their portfolio with the characteristics of feeders on their system (SCE 2015). For instance, savings on circuits with a large number of commercial customers are attributed energy efficiency savings consistent with the measures delivered to that sector. PG&E is currently studying approaches to further disaggregate energy efficiency savings under California's Energy Program Investment Charge research and development program (PG&E 2015b). New data analysis and planning tools could increase the spatial resolution of energy efficiency savings, giving distribution planners greater confidence in the level of energy efficiency savings that will occur on their circuits. Effective integration of these new tools would be reflected in the local load forecasts used by distribution planners, potentially delaying or eliminating the emergence of capacity constraints, thereby avoiding or deferring expensive grid upgrade investments.

2.3. Active Approaches

Where passive approaches reduce the number of distribution upgrade projects that are considered in the first place, active approaches consider new energy efficiency measures as an alternative to traditional infrastructure investments. Under active approaches, energy efficiency investments that are more cost-effective than conventional infrastructure can be identified and used to reduce the overall cost of the distribution system. In the case of California's model of delivering energy efficiency, an active approach could mean that system needs identified by distribution planners would inform the portfolios implemented by energy efficiency program administrators (Figure 3). In their DRPs and elsewhere, both SCE and PG&E have begun to explore how energy efficiency can be used as an active resource in the distribution system.

Figure 3: The California energy efficiency planning process with improved connection between distribution planning and efficiency. *Source:* Author

2.3.1 PG&E

In 2014, PG&E initiated its Targeted Demand Side Management (TDSM) program with the aim of identifying circuits with capacity constraints. Almost 150 candidate circuits were narrowed to four[4] where infrastructure deferral pilots that were largely centered on custom energy efficiency programs for large consumers were implemented (Aslin 2015). Importantly, the TDSM program is not just a new technical approach to distribution planning, but rather an attempt to improve the integration of PG&E's energy efficiency and distribution planning departments (Neme and Grevatt 2015). Where the traditional IEPR-based approach brings to mind a telephone game, cross-division collaboration within a utility encourages direct coordination between energy efficiency and distribution planning departments.

PG&E has proposed to build on the TDSM program in their DRP filing through an integrated DER deployment strategy in Fresno, California. Instead of considering project deferral solely on the basis of potential energy efficiency savings, this pilot will consider how energy efficiency can be used alongside solar PV, storage, and demand response (Aslin 2015). Furthermore, where the TDSM program relied on outreach within existing programs, the proposed pilot will use service-based contracts to procure DERs that can provide the right performance at the right locations.

2.3.2 SCE

SCE has been a leader among IOUs in using targeted procurement of energy efficiency. Following the unexpected permanent closure of the San Onofre Nuclear Generating Station (SONGS), SCE launched a targeted procurement of 'preferred resources' like solar, storage, demand response, and energy efficiency. As part of this procurement, SCE contracted for over 125 megawatts of energy efficiency savings that were additional to its own programs (SCE 2014). SCE also received approval from the CPUC to increase their custom program incentives

[4] Totaling 7.8 megawatts of demand.

by $30 per kilowatt (kW) within the affected region (SCE 2015). In its DRP filing, SCE cautioned that full evaluations of these strategies are not yet complete, but do offer them as potential paths forward for DER procurement (SCE 2015). SCE's response to the closure of SONGS demonstrates that active approaches to resource planning can identify energy efficiency savings that are additional to those delivered via traditional programs.

2.4 Summary of Energy Efficiency in California DRPs

IOUs state in their DRPs the need for more granular energy efficiency savings estimates and tools for cost-effective distribution planning. IOUs have described IEPR-based load forecasts as just one data point in their distribution planning processes (Billingsly et al. 2015). Distribution system upgrades are driven by local needs that cannot be easily determined through a state-level planning process. For instance, a planner faced with the development of a subdivision within their jurisdiction may not find a relatively uncertain aggregated estimate of energy savings to be a useful for their analysis. The AAEE disaggregation efforts by SCE and PG&E will help planners more effectively incorporate energy efficiency into their work, but it remains unclear how savings numbers that are derived using a kluge can be used to address a specific physical need that has been identified by planners.

Targeted deferrals of distribution infrastructure may instead rely on IOUs to actively include energy efficiency in distribution planning. Based on California IOUs' DRP filings, such active approaches are in a nascent stage. That said, both PG&E and SCE have implemented pilots that demonstrate new approaches to strategically deploy energy efficiency. As demonstrated in SCE's response to the closure of SONGS and the PG&E TDSM pilot, these new approaches can take the form of more targeted outreach within traditional utility energy efficiency programs and also procurement of third-party energy efficiency measures that meet defined performance criteria.

3. Lessons Learned and Recommendations

In their DRP filings, California IOUs identified both passive and active strategies to include energy efficiency in distribution planning. Both approaches have a role to play if the benefits of energy efficiency in the distribution system are to be realized. Incorporation of savings from existing energy efficiency programs into distribution planners' forecasts will reduce the number of system upgrades that are identified. When an upgrade need is identified, considering energy efficiency as an alternative to infrastructure investments may unlock savings that were not identified via traditional programs. However, additional work is needed if the full value of energy efficiency is to be realized in the distribution system.

3.1. Strategies to Improve Energy Efficiency Integration with Distribution Planning Under a Passive Approach

Successful passive strategies to include energy efficiency in distribution planning processes require savings to be disaggregated to specific geographies, ranging from the busbar to segments of feeders. Jurisdictions that are interested in better accounting of the distribution system impacts of energy efficiency should:

1. Undertake efforts like those of California IOUs to disaggregate savings from programs, appliance standards, and building codes.[5]

2. Encourage IOUs to pursue organizational modifications similar to those implemented by PG&E to better integrate the work of energy efficiency program managers and distribution planning staff (Neme and Grevatt, 2015). At a minimum, such collaborations can ensure that location specific energy efficiency measures funded by utilities are incorporated into distribution planning decisions. Energy efficiency departments within IOUs may also be able to offer insight as to where deemed savings or savings from building codes occur.

3. Consider modifications to cost-effectiveness tests so that targeted efficiency measures are valued accurately when energy efficiency portfolio net benefits are determined. A component of the California DRP proceeding is for utilities to conduct a locational net benefits analysis (LNBA) for DERs in their grid (CPUC 2014). Incorporating LNBA into energy efficiency cost-effectiveness evaluations would reward targeted efficiency measures that meet distribution grid needs.

3.2 Strategies to Actively Integrate Energy Efficiency in Distribution Planning

Active inclusion of energy efficiency in distribution system planning incentivizes IOUs to employ energy efficiency measures to mitigate or defer distribution grid needs. Strategies to improve the usefulness of active approaches include:

1. Apply location specific incentives in areas that face distribution system capacity constraints. SCE’s $30/ kW incentive in their post-SONGs procurement demonstrates this approach at a regional level (SCE 2015b). A similar approach has proven to be effective in a more narrowly defined geography in the Brooklyn Queens Demand Management (BQDM) pilot in New York City (ConEd 2015). In California, utilities and

[5] There are currently no evaluations of the efficacy of these approaches at. The successful aspects of the California IOUs’ passive strategies could be replicated elsewhere. Strategies that do not work can be viewed as lessons learned in the development of new distribution planning approaches.

regulators could develop a process to translate LNBA identified in the distribution planning process to increased incentives for targeted customers.[6]

2. Use the regulatory process to set out a standardized process that defines the conditions under which DER capacity procurement must be considered by utilities. As an example, Rhode Island requires that when transmission or distribution investments exceed $1 million utilities must consider non-wires alternatives to conventional upgrades (Neme and Grevatt 2015). Identifying threshold conditions for upgrades would allow DER providers a more clear understanding of what opportunities are available for their products and services.

3. Streamline active energy efficiency procurement by standardizing the contracting process. Without standardization, the transaction costs of participating in DER procurement may limit competition and the ultimate efficacy of an active approach. Strategies like pre-approval of vendors, minimum bid requirements to encourage aggregation of savings, and clearly defined operational characteristics would help to ensure that DER bids meet grid needs. Most of the value of DERs to the distribution system stem from capacity savings (Cohen et al. 2015). Distribution utilities should therefore consider lessons learned from wholesale system operators that manage capacity auctions. For instance, descending clock auctions used in wholesale markets like ISO-NE and PJM are an efficient means of price discovery (Poudineh and Jamasb 2013). In fact, descending clock auctions have begun to be used to procure DERs in the distribution system, the best example of which is the BQDM pilot in New York (ConEd 2015). Well standardized procurement approaches offer transparency for market participants that a contract by contract approach does not.

3.3 Implications of Utility Revenue Models for Energy Efficiency in Distribution Planning

Fundamental revenue model reforms may also be required to ensure utilities are fairly rewarded for implementing DER alternatives to conventional infrastructure investments. Utilities in the United States operate under cost-of-service regulation, where allowed rates of return are largely based on capital expenditures. Therefore, capital expenditures are the primary mechanism through which utilities create shareholder value (Kihm et al. 2015). In contrast, the approaches to better integrate DERs in distribution planning described above are examples of operational expenditures. Under cost-of-service regulation, operational expenditures are passed through to consumers with no return for shareholders. Investor-owned utilities have a responsibility to earn

[6] At present, the appropriateness of the LNBA methodology to account for energy efficiency is being contested in the DRP proceedings (Environmental Defense Fund 2016). Effectively tailored incentives would require that locational net benefit methodologies take into account the full value of DERs to the distribution system and spillover values to bulk power markets as well.

value for shareholders, so a financial upside for utilities may be needed if energy efficiency and other DERs are to be a core component of utility distribution planning. The corollary is that today's utility business models create a disincentive for IOUs to employ cost-effective energy efficiency and other DERs to defer infrastructure investments.

A starting place to adjust utility incentives could be through modifications to energy efficiency performance incentive mechanisms (PIMs). In states that use shared net benefits as the basis for shareholder incentives, use of locational benefit estimates in cost-effectiveness testing would enable utilities to increase the size of shared savings on which utilities earn shareholder returns. States that use energy savings as a basis for shareholder incentives may consider adding weights to targeted programs or add supplementary incentives for distribution system capacity reductions.[7] In fact, capacity-oriented incentives can also be applied as a PIM separate from those aimed at energy efficiency. Such a PIM may be preferable to jurisdictions that seek a technology-neutral approach to least-cost distribution system investments.

4. Conclusions

Energy efficiency has gained acceptance as a resource by a subset of both policymakers and utilities. This acceptance is reflected in the prominent role of energy efficiency in utility IRPs. As IRP-like distribution planning processes are launched, energy efficiency can be expected to again contribute to least-cost accomplishment of societal goals. This paper examined the approaches to include energy efficiency adopted by California utilities in their recently filed DRPs. Much of each utility's approach to energy efficiency is centered around passive accounting of existing energy efficiency programs in California. At present, savings from existing programs are not available at sufficient resolution to be included distribution planning. Active approaches have not yet been proven, with only a few pilots in California and elsewhere demonstrating the viability of energy efficiency via procurement to meet distribution grid operational needs. If the full value of energy to the distribution grid is to be realized, both passive and active strategies will need to be refined and broadly applied.

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[7] 13 states use shared savings reward mechanisms, 6 states base energy savings on gross energy savings and 5 states use multi-criteria reward schemes (Nowak 2014).

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